

Application No.: 09/985,693

Docket No.: 21806-00143-US

**REMARKS**

Claims 26, 28, 30-32, 35-45, 50, 52-54, and 56-57 remain pending in this application. Claims 26, 41, and 43 are now independent. Claims 41 and 43 have been amended, and no claims have been canceled or added by this response.

Applicants previously canceled non-elected species claims 33, 34, and 46-49 without prejudice or disclaimer, and reserve the right to timely file a divisional application to prosecute these species claims.

**Background Discussion of Applicants' Disclosure**

By way of background, one embodiment of applicants' disclosure is concerned with providing a method for joining two substrates in a semiconductor structure for "controlled collapse chip connection" (C4) interconnection of devices having self-aligning capabilities to ensure proper alignment of the two structures joined.

The C4 technology has a long history of producing reliable products at International Business Machines Corporation (IBM). The controlled collapse chip connection (C4) evaporative bump process, patented by IBM in the early 1960s, provides a method for producing multichip modules for the computer market and single chip packages for high-performance computing, for example.

The self-aligning aspects of Applicants' invention are brought about by using relatively "large" solder bumps to roughly, or initially align a plurality of C4 contacts between two substrates. Then, surface tension in wetted solder which is in contact with each of a plurality of C4 contacts is relied upon to finely align the tightly spaced C4 interconnects to a level, typically, within 10% of the solder bump diameter. The level of fine alignment of C4 interconnect achieved by Applicants' novel approach is submitted as not being achievable with conventional alignment techniques, such as are disclosed in the applied art, which rely upon physical force or external movement of the contacts to achieve alignment, as discussed below.

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Consequently, within the arena of C4 technology, the present application achieves an order of magnitude or more improvement in the number of C4 interconnects which are now possible to be joined. For example, as discussed in the Specification, the conventional limit for C4 interconnection technology, which has a C4 connection diameter of about 50mm, on a pitch of about 100mm, is, at most, about 10,000 C4 interconnects. This results in a chip having an area of about 1cm<sup>2</sup>. The structure and method of the present Application allows a much greater interconnect density, compared with current C4 technology, e.g., 100,000 interconnects per square centimeter, an order of magnitude or more increase, between the structures being joined.

For such an improved contact density, the contacts would have approximately, for example, a 15μm diameter, on a pitch of approximately 30μm. To achieve about 50% alignment of the C4 contacts, a 7.5μm alignment tolerance would be necessary from the initial alignment of the rough align solder bumps, i.e., the "larger" bumps. The large solder bumps have approximately a 10% alignment capability, allowing use of a solder bump having approximately a 75μm diameter, on a 150μm pitch. These limits on the large solder bumps are readily achievable with conventional component placement machines. The fine alignment achieved by the recited invention does not rely upon the machine placement accuracy, as long as the large solder bumps are placed within the above limits, for example. Surface tension acting on the C4 contacts is used to achieve the fine C4 interconnect alignment, and not physical movement or external prodding of the structures into alignment.

#### **Unpatentability Rejection over Nishiguchi and Kashiba**

Withdrawal of the rejection of claims 26, 28, 30-32, 35-37, 39-45, 50, 52-54, 56, and 57 under 35 U.S.C. §103(a) as being unpatentable over Nishiguchi (US 5,214,308) in view of Kashiba (JP 06-112463) is requested. The references are submitted as being combinable only by impermissible hindsight. Further, the assertion of "result-effective variable" and "obvious design choice" are respectfully traversed with respect to the various dependent claims.

At the outset, Applicant notes that, to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable

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expectation of success. Finally, *the prior art reference must teach or suggest all the claim limitations*.<sup>1</sup> Further, the teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in applicant's disclosure.<sup>2</sup>

Further, as stated in the MPEP and as held by the Federal Circuit, "[t]here are three possible sources for a motivation to combine references: the nature of the problem to be solved, the teachings of the prior art, and the knowledge of persons of ordinary skill in the art."<sup>3</sup> Further with regard to the level of skill of practitioners in the art, there is nothing in the statutes or the case law which makes "that which is within the capabilities of one skilled in the art" synonymous with obviousness.<sup>4</sup> The level of skill in the art cannot be relied upon to provide the suggestion to combine [or modify] references.<sup>5</sup>

### *Deficiencies of Nishiguchi*

In contrast to applicants' claimed invention, Nishiguchi et al. is directed to a substrate for packaging a semiconductor device having a relatively large bump, which is received by a recess having an electrode terminal therein. The particular point of novelty of Nishiguchi et al. appears to be the use of a recessed electrode terminal as shown in Figs. 2-3, rather than merely a flat electrode terminal. The recessed electrode terminal is used for "coarse" positioning by physically moving the device, e.g., with a component placement machine, and then more precise positioning is accomplished by "merely lightly pushing the semiconductor device to the packaging substrate after coarse positioning to assure that the tops of the higher bump electrodes do not swell out of the recesses formed in the higher electrode terminals, the bump electrodes on the semiconductor device can be highly precisely positioned to the electrode terminals on the packaging substrate."<sup>6</sup> Further, Nishiguchi does not teach or suggest use of bumps with different melting points.

<sup>1</sup> See MPEP §2143 (emphasis added).

<sup>2</sup> *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991) and See MPEP §2143.

<sup>3</sup> See MPEP §2143.01, citing *In re Rouffet*, 149 F.3d, 1350, 1357, 47 USPQ2d 1453, 1457-8 (Fed. Cir. 1998).

<sup>4</sup> *Ex parte Gerlach and Woerner*, 212 USPQ 471 (PTO Bd. App. 1980).

<sup>5</sup> See MPEP §2143.01, citing *Al-Site Corp. v. VSI Int'l Inc.*, 50 USPQ2d 1161 (Fed. Cir. 1999).

<sup>6</sup> See Nishiguchi et al., col. 1, line 63+.

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By using the approach of Nishiguchi et al., the precision requirement for a positioning machine used to place the components in position for packaging was relaxed from  $\pm 10\mu\text{m}$  to  $\pm 50\mu\text{m}$ . With reference to Fig. 2 of Nishiguchi et al., a representative size of bump 2 formed on the semiconductor device 1 is indicated as being  $80\mu\text{m}$  in diameter, while electrode terminal 5 on substrate 3 has a diameter of  $100\mu\text{m}$ .

The Examiner has chosen to read more into Applicants' previous comments regarding Nishiguchi with respect to C4 interconnect technology than is warranted, possibly due to a technical misstatement by the undersigned in the previous response.

Applicants have previously stated in the response filed September 23, 2004 that *"even if Nishiguchi et al. discloses a C4 interconnection structure which anticipates applicants' invention, not a clear proposition given the level of integration and density present in the present application, Nishiguchi et al., at best, represents the conventionally achievable C4 approaches which rely upon external, mechanical force to push the contacts into alignment."* (emphasis added). The Examiner incorrectly relies upon this statement as an "admission" that Nishiguchi is directed to C4 interconnect technology.

The undersigned acknowledges that the phrase "conventionally achievable C4 approaches" in the above quotation should more correctly have been "conventionally achievable approaches", as Nishiguchi does not teach or suggest C4 interconnect technology, as that term is understood by the assignee, IBM, or the inventors of the claimed invention, and as defined in the specification.

Further, the Examiner has apparently misunderstood Applicants' definition of "C4", as he referenced on page 2, lines 1-16 of the present specification, and as he incorrectly reads onto Nishiguchi.

Applicants have stated in the C4 definitional portion of the specification referenced by the Examiner that "C4 connections have *self-aligning capabilities* to ensure proper alignment of the two structures joined."

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Nishiguchi, on the other hand, requires an external, physical force or movement to accomplish coarse alignment by moving the “large” bump electrode 2a into recess 4. See Nishiguchi Figs. 6 and 7 and col. 5, lines 3-15, for example. Applicants submit that Nishiguchi thus does not teach or suggest “self-aligning capability”, since an external force is required to make the first coarse alignment.

Applicants reiterate that such conventional approaches taught by Nishiguchi, relying upon the “bump-in-hole” and external force technique for coarse alignment are unable to provide an interconnection density as in the present application, as described in Applicants’ background section of the Specification, and as discussed above.

To summarize, Nishiguchi discloses using a tapered recess in the substrate to roughly align the smaller contacts, not surface tension of the first solder bumps, and does not teach or suggest use of controlled-collapse chip connection (“C4”) contacts, which may also be defined as “[a] collapsed solder joint, between a substrate and a flip-chip, whose height is controlled by the surface tension of the liquid solder.”<sup>7</sup>

### ***Discussion of Kashiba***

Given that only the English language Abstract for Kashiba has been provided in the rejection, it is difficult to know with precision exactly what the Japanese language disclosure of Kashiba teaches or suggests.

With respect to independent claim 26, Kashiba is offered by the Examiner as teaching use of solder bumps having different solder composition and different solder melting points, and that it would be obvious to combine Kashiba with Nishiguchi “because it would facilitate alignment”.

This teaching regarding facilitation of alignment using different melting points or different solders is not found in Nishiguchi.

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<sup>7</sup> Electronic Packaging, Microelectronics and Interconnection Dictionary, Chas. A. Harper, and Martin B. Miller, McGraw-Hill, Inc., New York 1993, p. 44.

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***Specific Deficiencies of Nishiguchi in Combination with Kashiba***

Whether or not Kashiba teaches that for which the Examiner offers it, the combination of references as suggested by the Examiner is supportable only by the use of impermissible hindsight, by using Applicants' disclosure against them. For example, Nishiguchi does not teach C4 contacts, and further does not teach or suggest bumps having different melting points or solder types.

It is impermissible within the framework of 35 U.S.C. §103 to pick and choose from any one reference only so much of it as will support a given position to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one skilled in the art.<sup>8</sup> Further in this regard, As the Court of Customs and Patent Appeals, predecessor to the Federal Circuit, has held:

All relevant teachings of cited references must be considered in determining what they fairly teach to one having ordinary skill in the art. The relevant portions of a reference include not only those teachings which would suggest particular aspects of an invention to one having ordinary skill in the art, but also those teachings which would lead such a person away from the claimed invention.<sup>9</sup>

The rejections in the Official Action amount, in substance, to nothing more than hindsight reconstruction of Applicants' invention by relying on isolated teachings of the applied art, without considering the overall context within which those teachings are presented. Without benefit of Applicants' disclosure, a person having ordinary skill in the art would not know what portions of [Nishiguchi and Kashiba] to consider, and what portions to disregard as irrelevant or misleading.<sup>10</sup>

In particular, the applied art, alone or in combination, does not teach or suggest a method of fabricating a semiconductor structure which includes, among other features, "... providing a plurality of controlled collapse chip connection ("C4") solder bump contacts on one of the first substrate and the second substrate; providing first solder bumps on one of the first substrate and the second substrate, wherein the plurality of C4 solder bump contacts have a different solder

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<sup>8</sup> *Bausch & Lomb, Inc. v. Barnes-Hind/Hydrocurve, Inc.*, 230 USPQ 416 (Fed. Cir. 1986).

<sup>9</sup> *In re Mercier*, 185 USPQ 774, 778 (CCPA 1975).

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composition than the first solder bumps. . . reflowing the first solder bumps at a first temperature to initially align the plurality of C4 contacts by a surface tension of the reflowed first solder bumps; and finely aligning the plurality of C4 contacts by reflowing the plurality of C4 contacts at a second temperature higher than the first temperature,” as recited in independent claim 26, as amended.

Similarly, the applied art, alone or in combination, does not teach or suggest the method recited in independent claims 41 and 43.

Therefore, since the applied art does not disclose all the claimed limitations, consideration and allowance of independent claims 26, 41, and 43 are requested. Further, since dependent claims 28, 30-32, 35-40, 42, 44, 45, 50, 52-54, and 56-57 variously and ultimately depend from independent claim 26, these claims are submitted as being allowable at least on that basis, without recourse to the further patentable limitations contained therein.

***Traversal of Assertion that Contact Diameter and Pitch are “Result-Effective Variables”***

With respect to the various recitations of bump and/or pitch dimensions in various ones of the dependent claims, a result-effective variable is defined in the MPEP (Chap. 2100) as a variable which achieves a recognized result. The Examiner asserts that Nishiguchi and Kashiba teach that both contact pitch and contact diameter are result-effective variables, without offering comment on what “result” is recognized in the applied art, and how either contact pitch or contact diameter effect that result, or how either of these two parameters “optimize” any recited range of any method claim.

Similar to *In re Antonie*, 195 USPQ 6 (CCPA 1977) finding that a tank volume to contactor ratio was not a result-effective variable where the prior art did not recognize that wastewater treatment capacity was a function of that ratio, the applied art in these rejections does not recognize achievement of high C4 integration density, i.e., small C4 contact pitch and bump size, as being a function of solder surface tension of first solder bumps use to initially align a plurality of C4 solder bump contacts.

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<sup>10</sup> *In re Wesslau*, 147 USPQ 391, 393 (CCPA 1965).

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Accordingly, Applicants submit that the recited steps of independent claim 26, with the additional limitations of claims 39-44 were not known, at the time of the invention, to concern result-effective variables.

***Discussion of "Design Choice"***

The Examiner's assertion of "obvious design choice" appears to ignore the discussion of particular C4 contact spacing, provided above as background discussion, and as set forth in the Specification. This assertion appears to relate to dimensional recitations in various dependent claims.

In similar circumstances relating to claims to an apparatus, "[t]he BPAI held that appellant had simply made an obvious design choice. However, the different structures of appellant and of the reference achieve different purposes."<sup>11</sup> Further, "[t]o require an applicant to include in his specification evidence and arguments regarding whether particular subject matter was a matter of 'design choice' would be tantamount to requiring the applicant to divine, before an application is filed, rejections the PTO will proffer."<sup>12</sup> *A finding of 'obvious design choice' is precluded where claimed structure and the function it performs are different from those of the prior art.*<sup>13</sup> (emphasis added).<sup>14</sup>

Similarly, for the pending method claims, Applicants submit that a finding of "obvious design choice" should also be precluded when the applied art does not acknowledge the nature of the particular problem solved by Applicants' disclosed and claimed invention, i.e., achieving higher chip contact integration densities and reduced contact size and pitch with reliable contact alignment, as discussed above.

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<sup>11</sup> *In re Gal*, 980 F.2d 717, 719 (Fed. Cir. 1992).

<sup>12</sup> *In re Chu*, 66 F.3d 292, 298 (Fed. Cir. 1995).

<sup>13</sup> See *In re Chu*, 66 F.3d at 298, citing the holding of *In re Gal*, 980 F.2d 717, "(finding of 'obvious design choice' is precluded where the claimed structure and the function it performs are different from the applied art)."

<sup>14</sup> **Note:** The Examiner objected to this case law citation by stating that this statement is not found in *In re Gal*. The undersigned attorney notes that this citation represents the Federal Circuit's interpretation of *In re Gal*, as cited in and quoted from *In re Chu*. The undersigned attorney regrets any confusion that may have resulted.



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Without the C4 contact methodology in Applicants' disclosure, Applicants submit that the applied art could not achieve the bump size and alignment necessary for the higher contact integration and reduced pitch.

Accordingly, reconsideration and allowance of claims 39-44 are requested.

**Unpatentability Rejection over Nishiguchi and Kashiba in view of Love et al.**

Withdrawal of the rejection of claim 38 under 35 U.S.C. §103(a) as being unpatentable over Nishiguchi and Kashiba in view of Love et al. (US 5,773,889) is requested.

Even assuming that the references are properly combinable as suggested by the Examiner, Love does not make up for the previously identified deficiencies of Nishiguchi and Kashiba, as discussed above with respect to independent claim 26. Accordingly, reconsideration and allowance of claim 38 are requested.

**Anticipation Rejection over Kashiba**

Withdrawal of the rejection of claims 26, 28, 30-32, 35-37, 39, 42, 45, 50, 52-54, 56, and 57 under 35 U.S.C. §102(b) as being anticipated by Kashiba (JP 06-112463) is requested.

Applicants note that anticipation requires the disclosure, in a prior art reference, of each and every limitation as set forth in the claims.<sup>15</sup> There must be no difference between the claimed invention and reference disclosure for an anticipation rejection under 35 U.S.C. §102.<sup>16</sup> To properly anticipate a claim, the reference must teach every element of the claim.<sup>17</sup> "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference".<sup>18</sup> "The identical invention must be shown in as complete detail as is contained in the ...claim."<sup>19</sup> In determining anticipation, no claim

<sup>15</sup> *Titanium Metals Corp. v. Banner*, 227 USPQ 773 (Fed. Cir. 1985).

<sup>16</sup> *Scripps Clinic and Research Foundation v. Genentech, Inc.*, 18 USPQ2d 1001 (Fed. Cir. 1991).

<sup>17</sup> See MPEP § 2131.

<sup>18</sup> *Verdegaal Bros. v. Union Oil Co. of Calif.*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

<sup>19</sup> *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

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limitation may be ignored.<sup>20</sup> In view of the foregoing authority, the cited reference fails to anticipate independent claims 26, 41, and 43.

Kashiba is printed in Japanese. It is difficult to determine, with precision, exactly what Kashiba discloses other than the limited disclosure found in the English language Abstract.

It appears that Kashiba at least does not disclose a method of fabricating a semiconductor structure which includes, among other features, "... providing a plurality of controlled collapse chip connection ("C4") solder bump contacts on one of the first substrate and the second substrate," as recited in independent claim 26.

Further, Kashiba does not appear to disclose the particular limitations placed on bump size and pitch recited in independent claims 41 and 43.

Therefore, since the applied art does not disclose all the claimed limitations, consideration and allowance of independent claims 26, 41, and 43 are requested. Further, since dependent claims 28, 30-32, 35-37, 39, 42, 45, 50, 52-54, and 56-57 variously and ultimately depend from claim 26, these claims are submitted as being allowable at least on that basis, without recourse to the further patentable limitations contained therein.

#### **Unpatentability Rejection over Kashiba and Love**

Withdrawal of the rejection of claim 38 under 35 U.S.C. §103(a) as being unpatentable over Kashiba (JP 06-112463) in view of Love (US 5,773,889) is requested. The legal requirements for unpatentability have been set forth above.

Even assuming that the references are properly combinable as suggested by the Examiner, Applicants submit that Love does not make up for the apparent deficiencies of Kashiba, discussed above with respect to the anticipation rejection of independent claim 26 over Kashiba.

Accordingly, reconsideration and allowance of claim 38 are requested.

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### **Unpatentability Rejection over Kashiba**

Withdrawal of the rejection of claims 40, 41, 43, and 44 under 35 U.S.C. §103(a) as being unpatentable over Kashiba (JP 06-112463) is requested. The legal requirements for unpatentability have been set forth above.

As discussed above, Kashiba does not teach or suggest all the limitations of independent claim 26, from which claims 40 and 44 depend, as discussed above. Further, Kashiba does not teach or suggest all the limitations of independent claims 41 and 43. The previously presented arguments against the assertion of "result-effective variable" and "obvious design choice" for these claimed limitations are incorporated herein and are renewed in traversal of this rejection.

Accordingly, reconsideration and allowance of claims 40, 41, 43, and 44 are requested.

### **Conclusion**

In view of the above amendment and remarks, applicant believes each of pending claims 26, 28, 30-32, 35-45, 50, 52-54, and 56-57 in this application are in immediate condition for allowance.

In the event that the Examiner believes that an interview would serve to advance any remaining issues in this application, the undersigned attorney is available at the telephone number below.


The Examiner is requested to enter this amendment after final in that it raises no new issues, but merely, by distinguishing argument, places the claims in better condition for appeal. Further, the claim amendments were made merely to place previously considered dependent claims in independent form.

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Applicant believes no fee is due with this response. However, if a fee is due, please charge IBM's Deposit Account No. 09-0456, under Order No. 21806-00143-US from which the undersigned is authorized to draw.

Respectfully submitted,

By   
Larry J. Hume

Registration No.: 44,163  
CONNOLLY BOVE LODGE & HUTZ LLP  
1990 M Street, N.W., Suite 800  
Washington, DC 20036-3425  
(202) 331-7111  
(202) 293-6229 (Fax)  
Attorney for Applicant